Chicane Transverse-to-Longitudinal Emittance Exchange at ASTA

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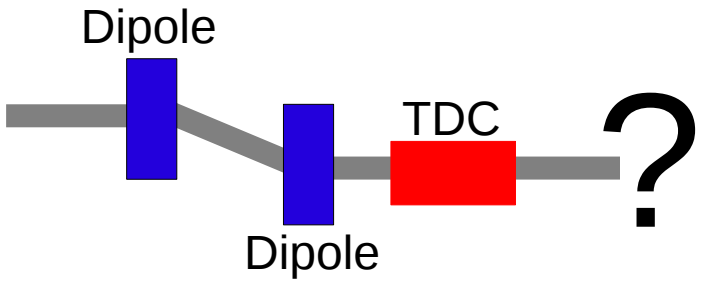
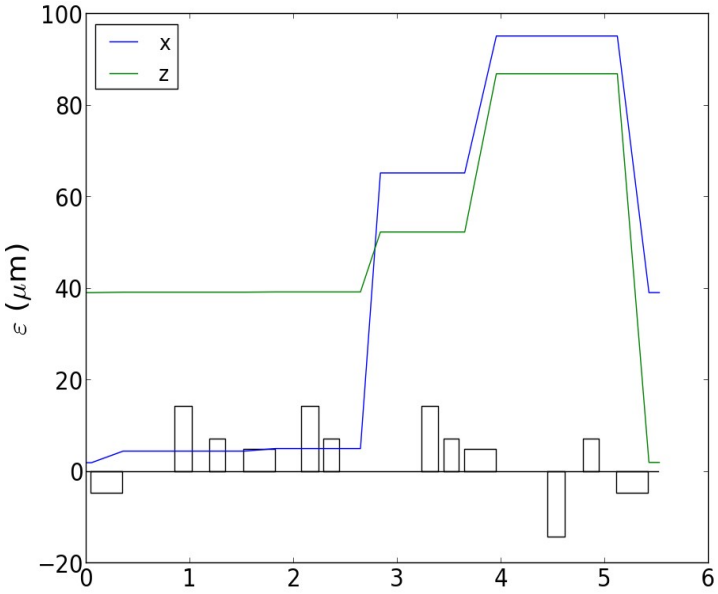
Basics of Emittance Exchangers

- TDC+ Dispersive Section
- Dogleg or Dipsersion-controlled Chicane
- Resulting transfer matrix is block anti-diagonal



$$R_{EEX} = \begin{pmatrix} 0 & 0 & R_{15} & R_{16} \\ 0 & 0 & R_{25} & R_{26} \\ R_{51} & R_{52} & 0 & 0 \\ R_{61} & R_{62} & 0 & 0 \end{pmatrix}$$

- Transverse shaping (transformations, collimation, quadrupoles, etc...) maps to current profile:
  - Triangular Hole → Ramped Bunch
  - Slits → Bunch Train
  - Big Hole & Little Hole → Drive Bunch & Witness Bunch
- 2nd order and collective effects reduce quality of exchange

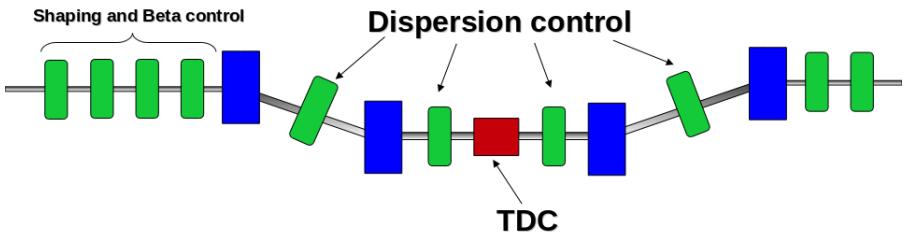


ASTA Chicane EEX

- Remains in-line with initial beam
- Can increase dispersion, reduce cavity strength

$$\kappa \equiv \frac{eV_x}{pc}\frac{2\pi}{\lambda} = -\frac{1}{\eta_x}$$

- Additional quads shape current by controlling R_{51} and R_{52}.
- R_{65} of TDC canceled by accelerating mode cavity.
- Simulations performed in Elegant, and Impact-Z for SC+CSR



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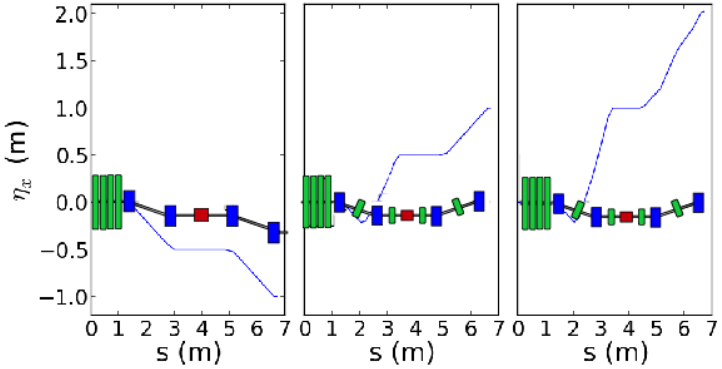
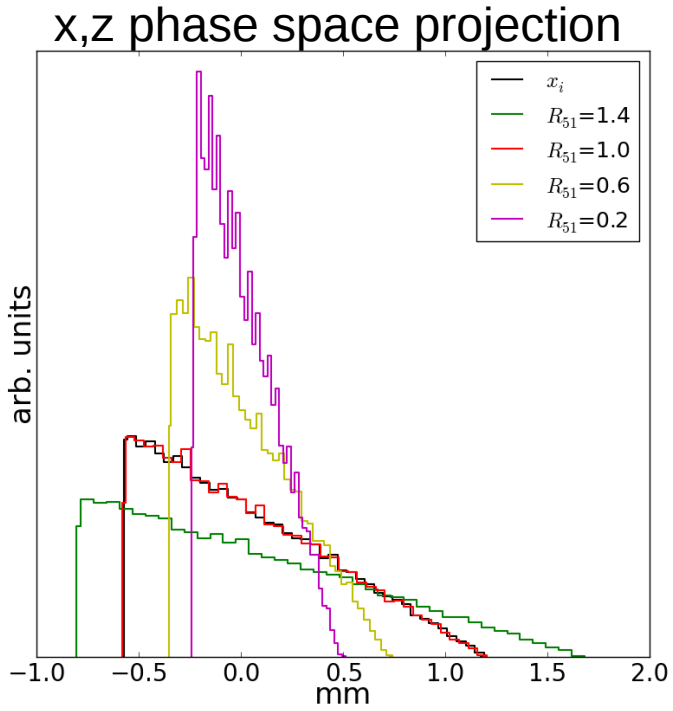
Double Dogleg (DDX) | Nominal-Dispersion Chicane (NDX) | Boosted-Dispersion Chicane (BDX)



Performance and Shaping

- Two criteria to judge:
  - Quantitative: $\mathcal{F}_{zx} \equiv \frac{\epsilon_{zf}}{\epsilon_{xi}}$ $\mathcal{F}_{xz} = \frac{\epsilon_{xf}}{\epsilon_{zi}}$
  - Qualitative: Preservation of Shaping

R_{51}	R_{52}	F_{xz}	F_{zx}
0.21	-0.025	1.04	1.27
0.6	0.0	1.03	1.25
1.0	0.0	1.16	1.66
1.4	0.0	1.28	2.134



Implementation at ASTA

- (1) Low-energy experimental line (50 MeV)
  - Would be first-ever chicane EEX.
- (2) Use same basic design at 250 MeV after CM1.
  - Could be used as first stage of dielectric wakefield “energy doubler”
- (3) Potential Double EEX
  - Still many designs to consider.